National Aeronautics and
Space Administration

Simulation of Shuttle SRB Ignition Transient with Sound Suppression Water

The Space Shuttle Program employed the Ignition Overpressure and Sound Suppression (IOP/SS) water system to reduce the acoustic energy load that occurs during ignition of the liquid main engines and the solid rocket boosters (SRBs). The IOP/SS water system uses 350,000 gallons of water in 41 seconds and starts flowing 7 seconds before liftoff.

NASA Marshall's workhorse computational fluid dynamics (CFD) flow solver Loci/CHEM has demonstrated the capability to model the complex interaction of water and supersonic plumes, which has been applied to the ignition transient of a single SRB with the IOP/SS water system. The enhanced flow solver was able to predict important flow characteristics like the peak pressures that were measured inside of the SRB hole during an actual launch.

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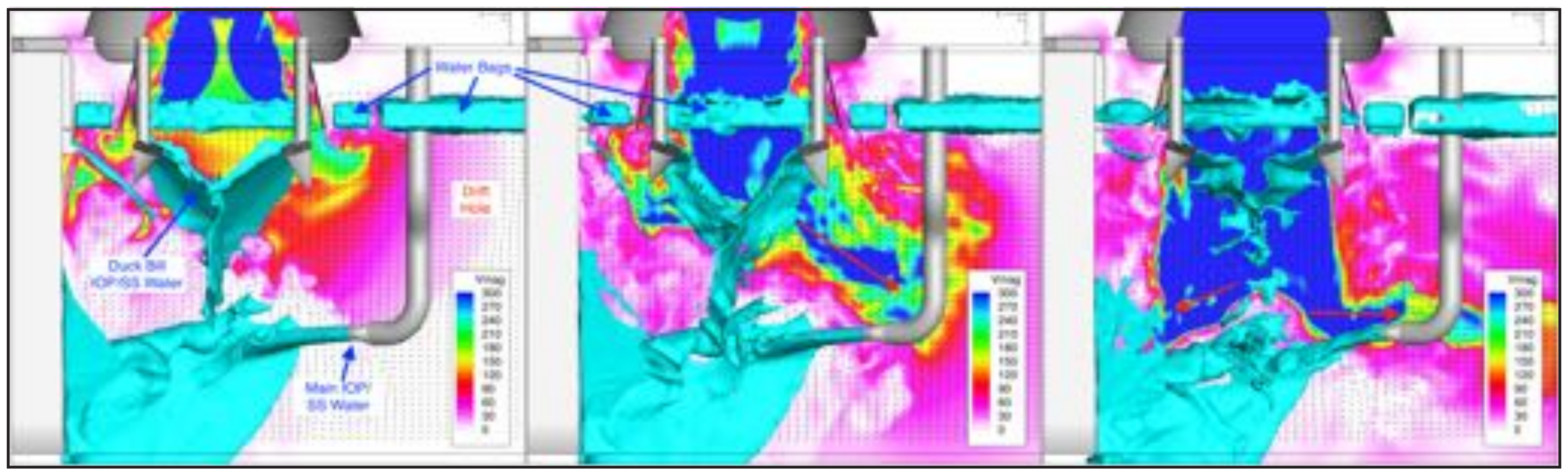
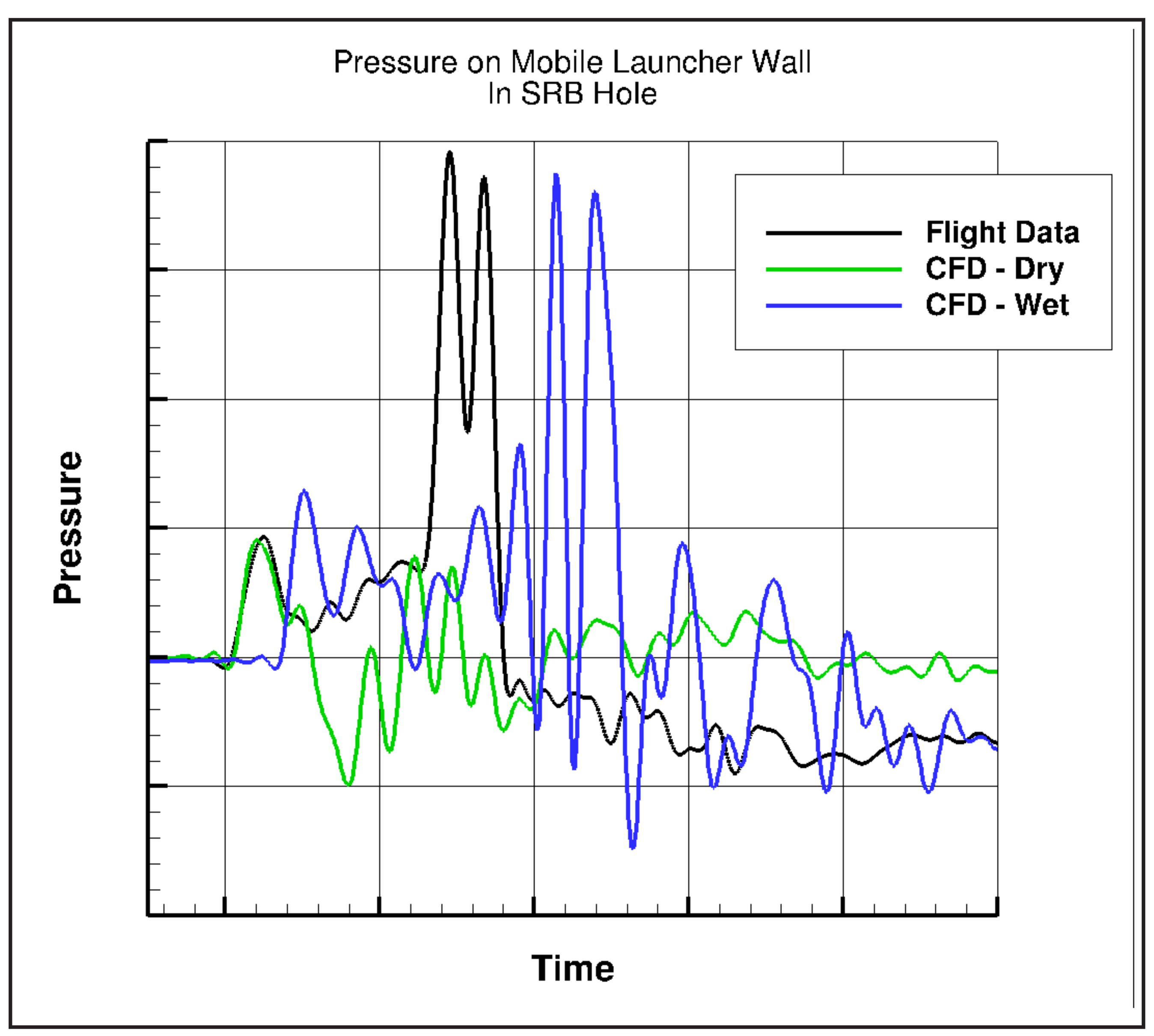
From left to right: progression of the space shuttle's solid rocket booster (SRB) plume inside of the SRB hole in the mobile launcher as it interacts with water from the Ignition Overpressure and Sound Suppression system. The images were captured by high-speed photography from flight STS-120 in October 2007. The hot plume exits the SRB nozzle and heads towards the drift hole, causing water to be expelled from the "water bags," and then disappears under the mobile launcher. *NASA*



Results of CFD simulations showing the velocity magnitude along the center of the SRB (water surface is shown as a cyan isosurface). Left: the plume exits the nozzle; the typical plume mushroom effect occurs under the "water bags." Center: the plume has reached the center water location; high-velocity gas propagates into the drift hole. Right: the plume has hit the main water and has split; half moves towards the drift hole, and half towards the wall. After a short time, the 3 million pounds of thrust generated by the SRB breaks through the water, but not before some of that energy has impacted the walls of the mobile launcher. *Jared Gudenkauf, NASA/Marshall*



The transient pressure at one location on the mobile launcher hole appears as two very large pressure waves during a space shuttle launch. Results from a CFD simulation without the IOP/SS water only capture the initial pressure impulse (ignitor shock) but fail to predict the large waves. However, when modeling with the IOP/SS water, the large pressure waves are predicted at the correct magnitude.